CHAPTER 3

Diversity in living organisms

Diversity is the variety of organisms present on earth whether they are plants, animals or microorganisms. To study them, a biologist should sort them out into some kind of meaningful order, i.e. classify them. Term biodiversity was coined by Walter. G.Rosen in 1986.

3.1 Taxonomy

Taxonomy is the branch of biology which includes identification, classification and nomenclature. Term taxonomy was given by A.P.de Candolle. Father of modern taxonomy is Carolus Linnaeus.

Taxon : Plant groups or animals groups included in categories are called taxon. e.g. Pisces, Insecta
Family - Brassicaceae
Genus - Raphanus
Species - *sativus*

Here FAMILY is a category in which BRASSICACEAE group is a taxon.

Identification

Correct description of an organism is known as identification and nomenclature is only possible when we describe organism correctly.

Nomenclature

When we decide some standard name of any organism, this process is known as nomenclature. Some principle criteria are decided by ICBN (International Code for Botanical Nomenclature), ICZN (International Code for Zoological Nomenclature). The scientific names ensure that each organism has only one name. Carolus Linnaeus was the scientist who proposed the binomial nomenclature which states that each name has two components, the generic name and the specific epithet. e.g. mango-*Mangifera indica.*

Nomenclature have some universal rules as follows:

(i) Scientific name are generally in Latin or Latinized and written in Italics.
(ii) The first word represents the genus and second denotes species.
(iii) Hand written scientific name are separately underlined Mangifera indica.
(iv) Generic name always start with capital letter and specific name with small letter.
(v) Name of the author or inventor or discoverer should be written in abbreviated form after the species. Eg. Mangifera indica Linn. It indicates that this species was first described by Linnaeus.

Classification

It is a process by which organisms are grouped into convenient categories based on their characters. Hence characterisation, identification, classification and nomenclature are the process that is basis of taxonomy. Linnaeus published a book SYSTEMA NATURAE in which he referred a term systematics which is a latin word meaning systematic arrangement of organisms. In this branch we also study the relationship among the organisms.

Taxonomic categories

All taxonomic categories together constitute taxonomic hierarchy (ranking).

Hierarchy : Hierarchy is a system of classification into which taxonomic categories are arranged in descending order. Common categories in hierarchy are kingdom, phylum (for animals)/division (for plants), class, order, family, genus and species. Species is the lowest category.

Species : It is the group of individual organisms with similar characters and which can interbreed so as to produce fertile offsprings. They are all closely related, e.g. *Mangifera indica, Solanum tuberosum* (potato), *Panthera leo* (lion). All these names like indica, tuberosum, leo represent the specific epithets.

Genus : It is the group of related species which have common character, e.g. Lion (*P.leo*), Leopard *(P.pardus)* and Tiger *(P. tigris)*. In all these Panther genus is common which includes three different species because they have several common characters.

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Family : Family is a group of related genera with some common features, e.g. Solanaceae family includes three genera Solanum, Petunia and Datura.

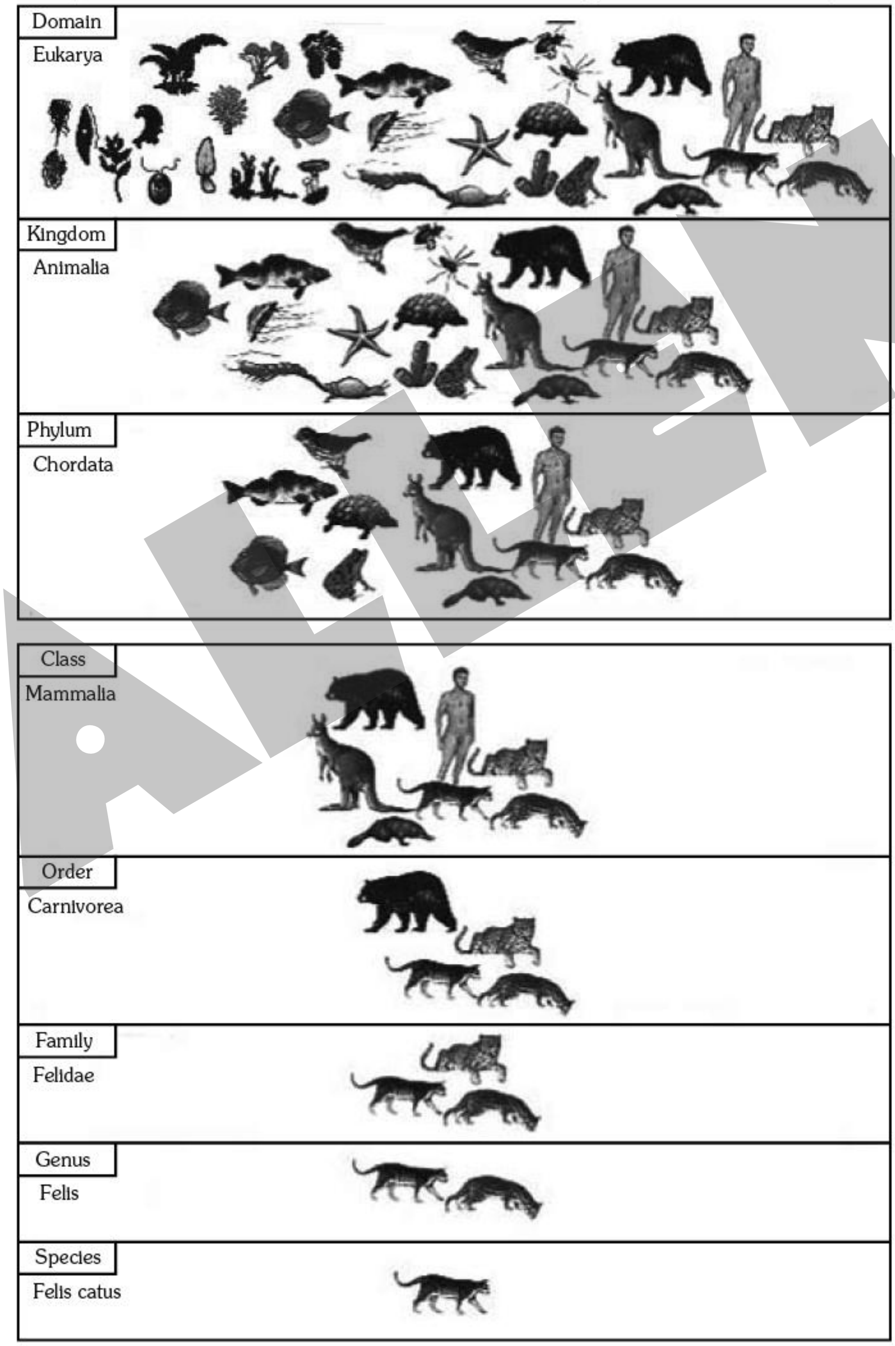
Order : Order includes many families which exhibit little similarity, e.g. the order Carnivora includes families like Felidae (cat), Canidae (lion).

Class : It includes related orders, e.g. Order Primata which includes monkeys, gorillas and gibbons is placed in class Mammalia.

Phylum : Many classes with some common characters are included in Phylum. Phylum Chordata includes classes like Pisces, Amphibia, Reptilia, Aves and Mammalia.

Kingdom : Various phyla/division are grouped in the highest category called kingdom, e.g. Animal kingdom and Plant kingdom.

Kingdom → Phylum/division → Class → Order → Family → Genus → Species



Taxonomic Categories

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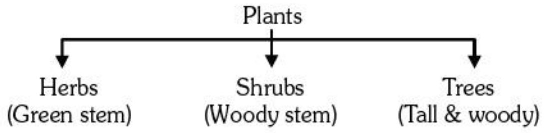
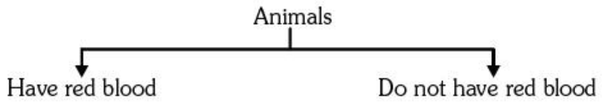
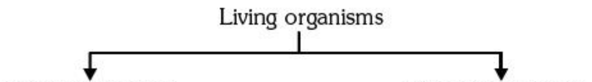
3.2 Biological classification

To study the organisms on earth scientists proposed different system of classification. Aristotle was the first who gave the classification on the basis of height of the plants.





Two Kingdom classification- It was given by Carolus Linnaeus.



Drawbacks of two kingdom classification:-

(i) This system did not distinguish prokaryotes and eukaryotes.

(ii) Unicellular and multicellulars are not distinguished.

(iii) Green and non green plants are not categorized.

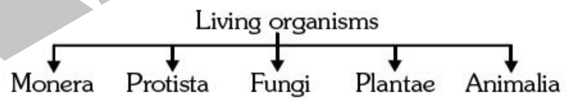
So this classification underwent several changes over time.

Three kingdom classification- It was proposed by Ernst Haeckel in 1886. He suggested a third Kingdom Protista for unicellular organisms.

Four kingdom classification- It was given by Copeland. He included Kingdom Monera (Mychota) for prokaryotes.

Five kingdom classification

It was proposed by R.H.Whittaker in 1969 which was based on the characters like cell type, cell wall, nuclear membrane, body organization and mode of nutrition. This classification includes the group of bacteria, blue green algae, and fungi. etc. It also distinguishes the prokaryotes and eukaryotes, unicellular and multicellular and other relationships also.



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3.3 Kingdom Monera

Carl Woese has divided the kingdom Monera into Archaebacteria and Eubacteria.

(i) All prokaryotic unicellular organisms are included in Monera.

(ii) According to the shapes they are coccus (spherical), bacillus (rod), vibrio (comma), spirillum (spiral).

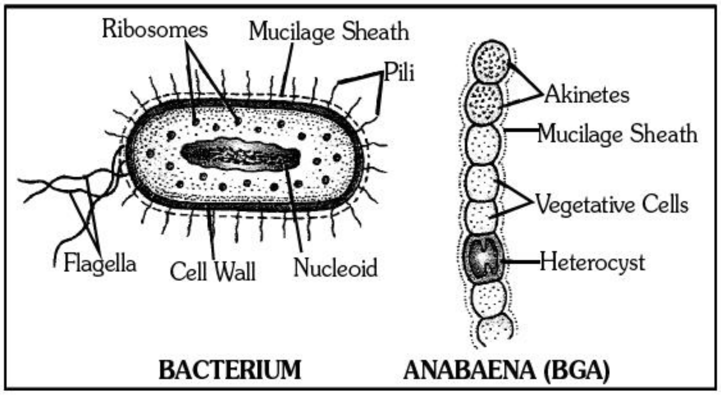
(iii) Some of these are photosynthetic autotrophs because they contain chlorophyll in them.

(iv) Some of the bacteria obtain their energy by some chemical reactions, they are known as chemosynthetic autotrophs, e.g. Nitrosomonas and Nitrobacter (bacterias playing role in nitrogen cycle).

(v) Majority of bacteria are heterotrophic, i.e., depend on other organisms or on dead organic material.

(vi) Cell wall is not made up of cellulose but with polysaccharides and amino acids (peptidoglycans and murein).

(vii) All nitrogen fixing organisms belong to Monera (e.g., Rhizobium in root nodules of legumes). Some Monerans take part in ammonification, nitrification and denitrification.



Kingdom Monera

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Monera is divided into two groups

1. Archaebacteria

(i) They live in very harsh habitats such as extreme salty area (halophiles), hot springs (thermoacidophils), marshy areas (methanogens).

(ii) The cell wall is different than other bacterias which is responsible for their survival in the extreme conditions. For example,

(a) Methanogens : They are present in the guts of several ruminant animals such as cow and buffaloes and they are responsible to produce methane or biogas from the dung of these animals. They are strict anaerobes and die in the presence of oxygen.

(b) Thermoacidophiles (Heat Lovers) : They are aerobic forms of bacteria found in hot sulphur springs.

(c) Halophiles (salt lovers) : These are anaerobic forms associated with coccoid forms of bacteria.

2. Eubacteria

(i) There are thousands of different eubacteria or true bacteria. They have rigid cell wall and are motile if they have flagella.

(ii) Some of them are known as cyanobacteria or blue green algae having chlorophyll 'a' to do photosynthesis (photosynthetic autotrophs). They are unicellular, colonial, filamentous, marine or terrestrial algae. The colonies are surrounded by gelatinous sheath. They often form blooms and pollute water bodies.

(iii) Some organisms fix atmospheric nitrogen by specialized cell called heterocyst, e.g., *Nostoc* and *Anabaena*.

(iv) Majority of bacterias are heterotrophic. They are useful for mankind in making curd, production of antibiotics, fixing nitrogen in leguminous plants. Some bacteria are pathogenic causing damage to farm animals, humans , crops by causing diseases like typhoid, tetanus, citrus canker etc.

(v) Bacteria reproduce by fission or by spore formation.

(vi) Mycoplasma is the smallest living cell which lacks the cell wall and can survive without oxygen; many of them are pathogenic for plants and animals.

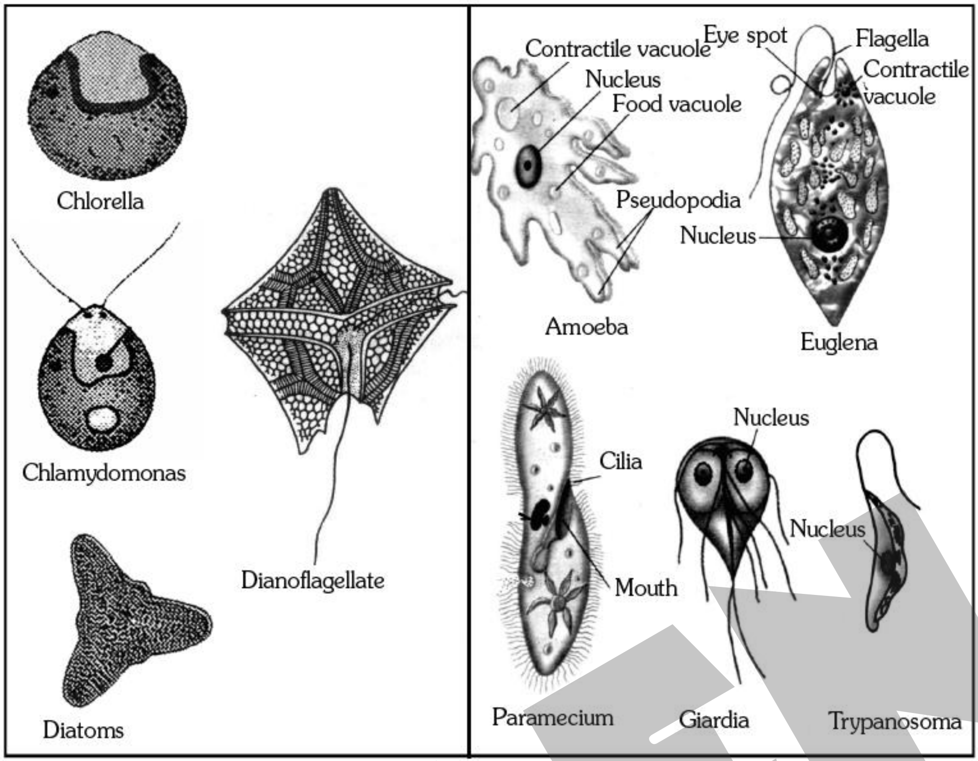
3.4 Kingdom Protista

(i) They are single celled eukaryotes.

(ii) They have well defined nucleus and membrane bound organelles. Some have flagella and cilia.

(iii) They reproduce asexually and sexually by producing zygote.

(iv) Kingdom Protista includes phylum chrysophytes, dinoflagellates, euglenoids, slime moulds and protozoans.



Kingdom Protista

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Chrysophytes

(i) This group includes diatoms and golden algae also known as desmids.

(ii) They are found in fresh and marine water, microscopic, float with water current which are known as planktons.

(iii) Most of them are photosynthetic (chief producer).

(iv) In diatoms cell wall is formed of two thin overlapping shells which fit together like soap box, wall also contains silica so diatoms left behind large amount of cell wall deposited in their habitat which accumulates over billions of years and are known as diatomaceous earth. Diatoms are gritty so they are used in filtration of oils and syrups.

Dinoflagellates

(i) They possess two dissimilar flagella arising from the ventral cell side one transverse and other longitudinal flagella.

(ii) Cell wall has stiff cellulose plate on the outer surface.

Euglenoids

(i) In place of cell wall they have protein layer called pellicle which make their body flexible.

(ii) They have green pigments so they do photosynthesis in the presence of sunlight but in the absence of light they behave like heterotrophs by predating on other smaller organisms.

Slime moulds

(i) They are saprophytes living on decaying twigs and leaves.

(ii) Under suitable conditions they form aggregates called plasmodium which may grow and spread over the several feet.

(iii) They do not have cell wall, have amoeboid nature e.g. Physarum

Protozoans

(i) They all are heterotrophs and most primitive relatives of the animals. They have four major groups on the basis of how they move.

(a) Amoeboids : They live in fresh water, sea or in moist soil. They form pseudopodia or false feet for locomotion and to capture their prey, e.g. *Amoeba*.

(b) Flagellates : They have flagella, free living or parasite. *Trypanosoma,* is a flagellate parasite causing sleeping sickness.

(c) Ciliated : They are aquatic having cilia for locomotion, e.g. *Paramecium*.

(d) Sporozoans : Pathogenic or parasitic protists, e.g. *Plasmodium*.

3.5 Kingdom Fungi

(i) They are heterotrophs which may be saprophytes and parasites.

(ii) Some of them cause disease in plants and animals, e.g. Wheat rust caused by *Puccinia*, Ringworm in animals.

(iii) They may be unicellular or multicellular.

(iv) Plant body known as mycelium is made up of thread like structures called hyphae.

(v) Cell wall is made up of chitin.

(vi) Some fungi live with algae in symbiotic association called lichen and some fungi live with roots of higher plants known as mycorrhiza.

(vii) Reproduction takes place by vegetative propagation means like fragmentation, fission and budding. Asexual reproduction occurs by conidia or sporangiopore or zoospores.
Sexual cycle involves three steps (a) plasmogamy-fusion of protoplasm of two gametes. (b) karyogamy-fusion of two nucleus (c) meiosis in zygote.

(viii) Most of the members like morels and truffles are edible and neurospores like members are used in labs for biochemical and genetic works.

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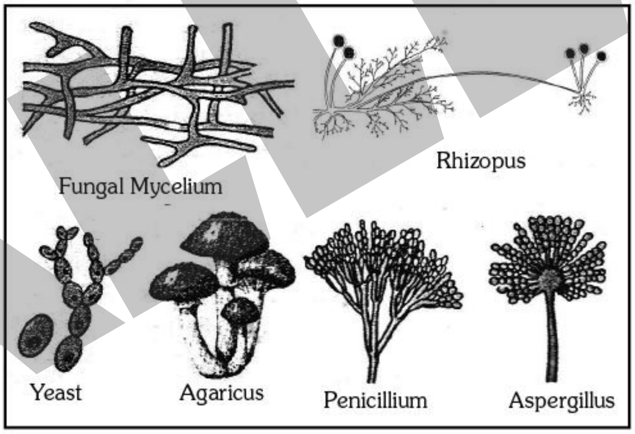
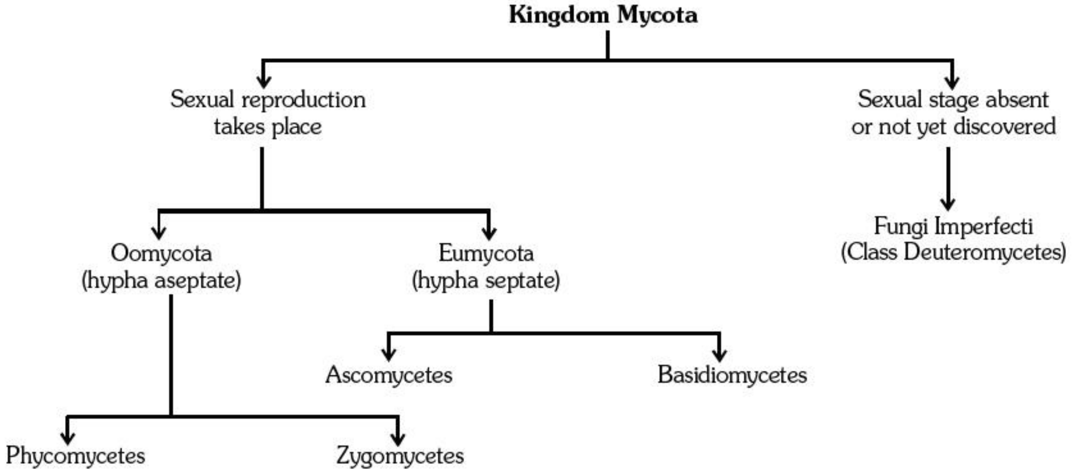


Some common fungi


Kingdom Mycota
Sexual reproduction takes place
Sexual stage absent or not yet discovered
Oomycota (hypha aseptate)
Eumycota (hypha septate)
Fungi Imperfecti (Class Deuteromycetes)
Ascomycetes
Basidiomycetes
Phycomycetes
Zygomycetes

3.6 Kingdom Plantae

(i) It includes all eukaryotes containing chloroplast.
(ii) Few members are parasitic (cuscuta); some are insectivorous (pitcher plant).
(iii) It includes algae, bryophytes, pteridophytes, gymnosperms, angiosperms.
(iv) Life cycle having two phases : sporophyte (2n) and gametophyte (n).
Gametophyte : It is haploid plant structure which produce gametes directly.
Sporophyte : It is diploid (with two sets of chromosomes) plant structure which produces haploid spores through the process of meiosis.

Plant kingdom is divided into following groups : algae, bryophyte, pteridophyte, gymnosperm and angiosperm.

Algae

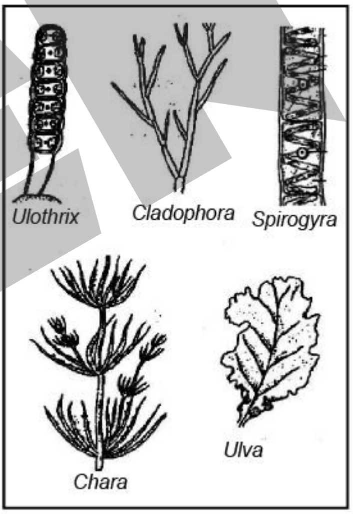
They contain pigment chlorophyll, body is simple not differentiated into stem, root and leaves (thallus), mostly aquatic, may live on moist stone, soil or wood.

Sometimes they are associated with fungi and form lichen or may be associated with animals like slothbear.

Size varies from microscopic unicellular *(Chlamydomonas)*, colonial form *(Volvox)*, filamentous form *(Ulothrix)* or massive plants like Kelp.

Reproduction occurs by the following means.
(i) Vegetative method (fragmentation)
(ii) Asexual method
(iii) Sexual method

- Algae fix half of the total CO_2 on earth through photosynthesis and dissolve O_2 in the water so it is an important primary producer for aquatic animals.
- Many species like porphyra, laminaria and sargassum and 70 species of marine algae used as food.
- Few brown and red algae produce large amount of water holding substances called hydrocollides, e.g. Algin extracted from brown algae and carrageen from red algae used commercially.
- Agar extracted from Gelidium and Gracilaria are used to grow microbes in laboratory and for preparation of ice-creams and jellies.
- Some algaes rich in proteins are used by the space travellers, e.g. Chlorella and Spirulina.
- On the basis of pigments algae are divided into 3 classes: Chlorophyceae, Rhodophyceae and Pheophyceae.



Some common thallophytes (algae)

Characteristics	Chlorophyceae	Pheophyceae	Rhodophyceae
Common name	Green algae	Brown algae	Red algae
Major pigment	Chlorophyll a, b	Chl a and c, carotenoids, xanthophylls,fucoxanthin.	Chl a, d and phycoerythrin.
Plant body	Unicellular, colonial and filamentous.	Simple, branched filament, may be 100m long, divided into holdfast, stipe and frond.	Multicellulars, compact body organization.
Examples	*Chlamydomonas, Volvox, Ulothrix, Chara*	*Ectocarpous, Laminaria and Sargassum*	*Polysiphonia, Gracilaria, Porphyra*

Lichens

It is a symbiotic association of algae and fungi. Algae part is known as phycobiont which perform photosynthesis whereas fungal part is known as mycobiont which absorbs minerals and waters for its partner. They do not grow in polluted areas hence are also known as pollution indicator or bioindicators of pollution.

Bryophytes

(i) It includes mosses and liverworts, found in the shady areas of hills.

(ii) They are amphibious in habit because they live in soil but need water for reproduction. So, they are always found in damp and shady places. They have important role in plant succession on bare rocks and soil.

(iii) Plant body is thallus attached to the substratum by unicellular or multicellular rhizoids.

(iv) Some members are differentiated into rhizoid, stem and leaf like structures.

(v) Main plant body is gametophyte bearing multicellular female reproductive organ called archegonia which is flask shaped and globular male reproductive organ called antheridia.

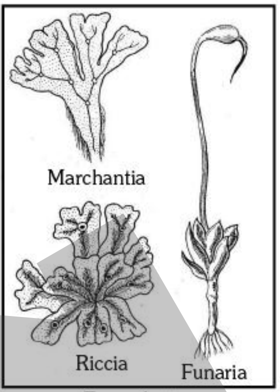
(vi) Antheridia release antherozoids which fuses with egg to form zygote.

(vii) Zygote develops into sporophyte and dependent totally on gametophyte for the nutrition (parasitic sporophyte).

(viii) Sporophyte is differentiated into foot, seta and capsule in which capsule produces the spores after meiosis.

(ix) Spores released from the capsule and germinate to form a filamentous like structure called protonema by which again gametophyte will develop.

(x) Economic importance-it is used as a food for mammals, birds and other animals. Species of Sphagnum provide peat (form of coal) that has been used as fuel. They have the capacity to hold water so they are used in packing material in transport. Mosses and lichens decompose the rock making the substratum for the growth of the higher plants. Mosses forms a cover on the soil so they attract the rain and prevent soil erosion, e.g. *Funaria*, *Polytrichum*.



Bryophytes

Pteridophytes

(i) It includes horse-tail and ferns. They are used to form medicines, soil binder and as ornamental plants.

(ii) These are the first terrestrial plants possess vascular system having xylem and phloem but xylem lacks the vessels and phloem lacks the companion cells and sieve tube.

(iii) They are found in cool, damp and shady places.

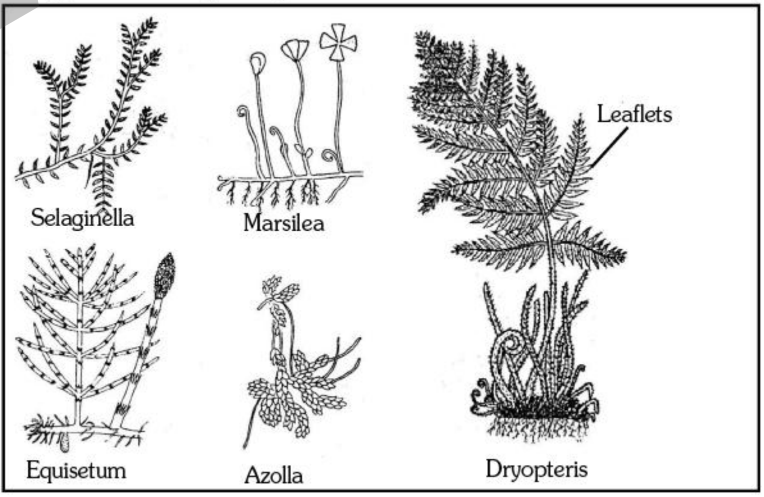
(iv) Sporophyte phase is dominant which possess stem, root and leaves.

(v) Sporophytes develop the sporangia at the ventral sides of the leaves. These leaves are known as sporophylls. In some species these sporophylls form a compact structure called as strobilus or cone as in *Selaginella*, *Equisetum*.

(vi) Spores formed in sporangia are haploid as they are produced after meiosis. Spores germinate to form gametophyte called prothallus which grows in cool and damp places because they need water for the reproduction.

(vii) Gametophyte bears archegonia and antheridia. Fusion of male gamete with the egg present in the archegonium results in the formation of zygote which later on developes into sporophyte.

(viii) Development of zygote into embryo as a precursor of the seed habit is considered as an important spot in evolution.



Pteridophytes

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Gymnosperms

(i) Gymnosperms means naked seed, i.e., ovules are not enclosed by ovary wall.

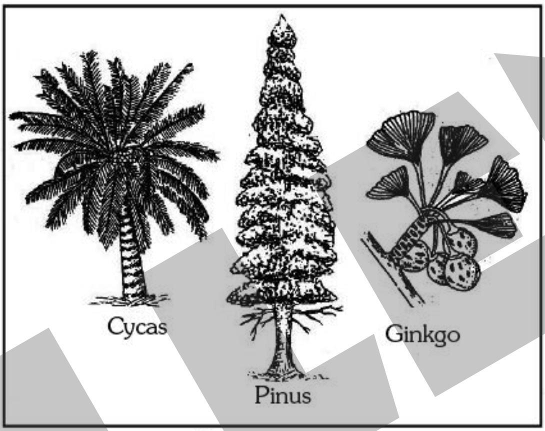
(ii) Plants are medium sized, some are shrubs, and tallest tree is *Sequoia*.

(iii) Roots are tap root and in some plants like Pinus, fungus association is their which are called Mycorrhiza.

(iv) Gymnosperms are heterosporous. Microspores develop in microsporangia on microsporophylls which are completely arranged to form male strobilli or cones. Microspores are responsible to develop male gametophyte which is highly reduced called pollen grains. Megaspores develop into megasporangia on megasporophylls which are also arranged in cones.

(v) The pollen produced by these plants is dispersed by wind, insect, etc. The zygote, or fertilized egg, develops into an embryo. The embryo and the food it uses to grow are covered by a protective seed coat.

In the course of evolution, the gymnosperms appeared before the angiosperms. All conifers (evergreen plants) like pines, firs, cedars and redwoods are gymnosperms. Conifers are among the largest trees and constitute the major source of pulp and paper. Cycads (Cycas) are palm like gymnosperms, but unlike palms, they bear naked seeds on the scales of cones. Gymnosperms do not have flowers, e.g. *Pinus, Cycas* etc.



Gymnosperms

Angiosperms

(i) In angiosperms flower is the reproductive structure.

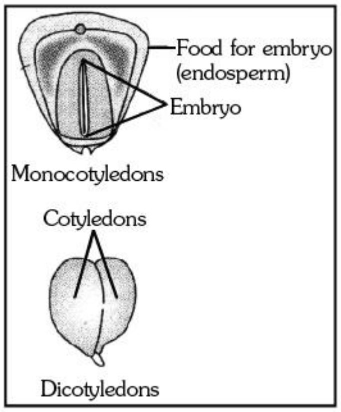
(ii) It is the dominant group on the earth which ranges from the microscopic plant *Wolffia* to tall trees like *Eucalyptus* over 100 m.

(iii) It provides food, fodder, fuel, medicine and several other things for commercial use.

(iv) Flower consists of stamen as male reproductive organs and pistil as female reproductive organs.

(v) Flowers may be unisexual or bisexual. Pollination occurs by wind, water and animals. Endosperm is a new food storing structure which is generally triploid and is formed by fusion of three nuclei (triple fusion).

(vi) According to the number of cotyledons in the seeds they are further divided into two classes- dicotyledons and monocotyledons.



Monocotyledons : Bear seeds which have a single cotyledon, or seed leaf. The veins on their leaves are parallel to each other. Their vascular bundles (xylem and phloem) are arranged in a complex manner. Their root system, called fibrous root system, consists of a network of roots, with no distinct main root. Palms, bamboos, grasses, sugar cane, rice, wheat and corn are some monocotyledons.

Dicotyledons : The seeds of dicotyledons like grams, peas, beans, sunflower and rose have two cotyledons. The veins on their leaves are reticulate or like a network. Their vascular bundles are arranged in a ring. Their root system called tap root system, consists of a main tap root with smaller branching root.

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3.7 Kingdom Animalia

(i) They are heterotrophic, multicellular and lacking cell wall.

(ii) They digest the food in an internal cavity and store food as glycogen. Their mode of nutrition is Holozoic.

(iii) They have definite growth pattern.

(iv) Sexual reproduction is by copulation of male and female followed by embryological development.

Basis of classification in Animal kingdom

(i) Cell type-All members of kingdom animalia possess eukaryotic cell i.e. membrane bound cell organelles and nucleus.

(ii) Level of organization-Though all members of animalia are multicellular, all of them do not exhibit the some pattern of organisation of cells.

e.g. : Cellular - Sponges ; Tissue - Coelentrata ; Organ - Platyhelminthes ; Organ system - Annelids to Echinoderms and Chordates.

(iii) Body symmetry- Symmetry relates to the arrangement of body structures in relation to the body axis.

(a) Assymetry : Most sponges are not symmetrical, so when sponge is cut in half, the two halves are not similar to each other.

(b) Radial symmetry : In radial symmetry, the body has the general form of a wheel or cylinder and similar structures are regularly arranged as spokes from a central axis. Multiple planes can be drawn through the central axis, each dividing the organism into two mirror images.

(c) Bilateral symmetry : Most animals exhibit bilateral symmetry, at least in their larval stages. A bilaterally symmetrical animal can be divided through only one plane (which passes through the midline of the body) to produce roughly equivalent right and left halves that are mirror images.

(iv) Germinal layers - They are the primary layers that differentiate in the embryo. All tissues and organs of the animal body develop from them. In animals either two or three germ layers are present.

(a) Diploblastic : Animals in which the cells are arranged in two embryonic layers ectoderm and endoderm with an interveining mesoglea e.g., Coelentrates and Ctenophores.

(b) Triploblastic : Those animals in which the developing embryo has a third germinal layers - Mesoderm in between ectoderm and endoderm e.g., Platyhelminthes to Chordates.

(v) Body cavity-Biologists can classify triploblastic animals based on the presence and type of body cavity, or coelom, a fluid-filled space between the body wall and the digestive tube.

(a) Acoelomate : The animals in which body cavity is absent is called acoelomate. e.g., Platyhelminthes

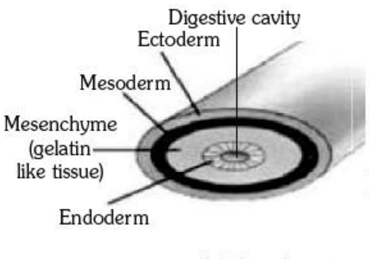
(b) Eucoelomate : The body cavity are completely lined with mesoderm. Such a body cavity is a true coelom. Animals with true coelom are eucloemates.

(c) Pseudocoelomate : The body cavity is not completely lined with mesoderm, this type of body cavity is called pseudocoelom.

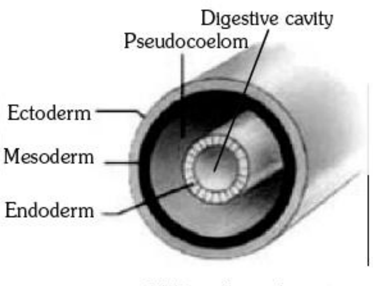
(vi) Notochord : It is a mesodermally derived rod like structures formed on dorsal side during embryonic development in some animals.

(a) Non chordates : Animals without notochord. e.g. Porifera to Echinodermata.

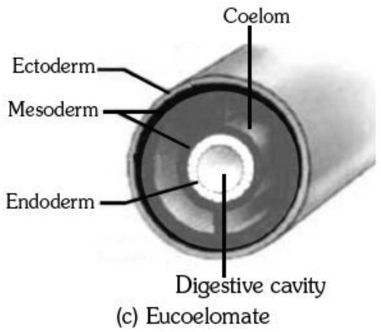
(b) Chordates : Animals with notochord.



(a) Acoelomate



(b) Pseudocoelomate



(c) Eucoelomate

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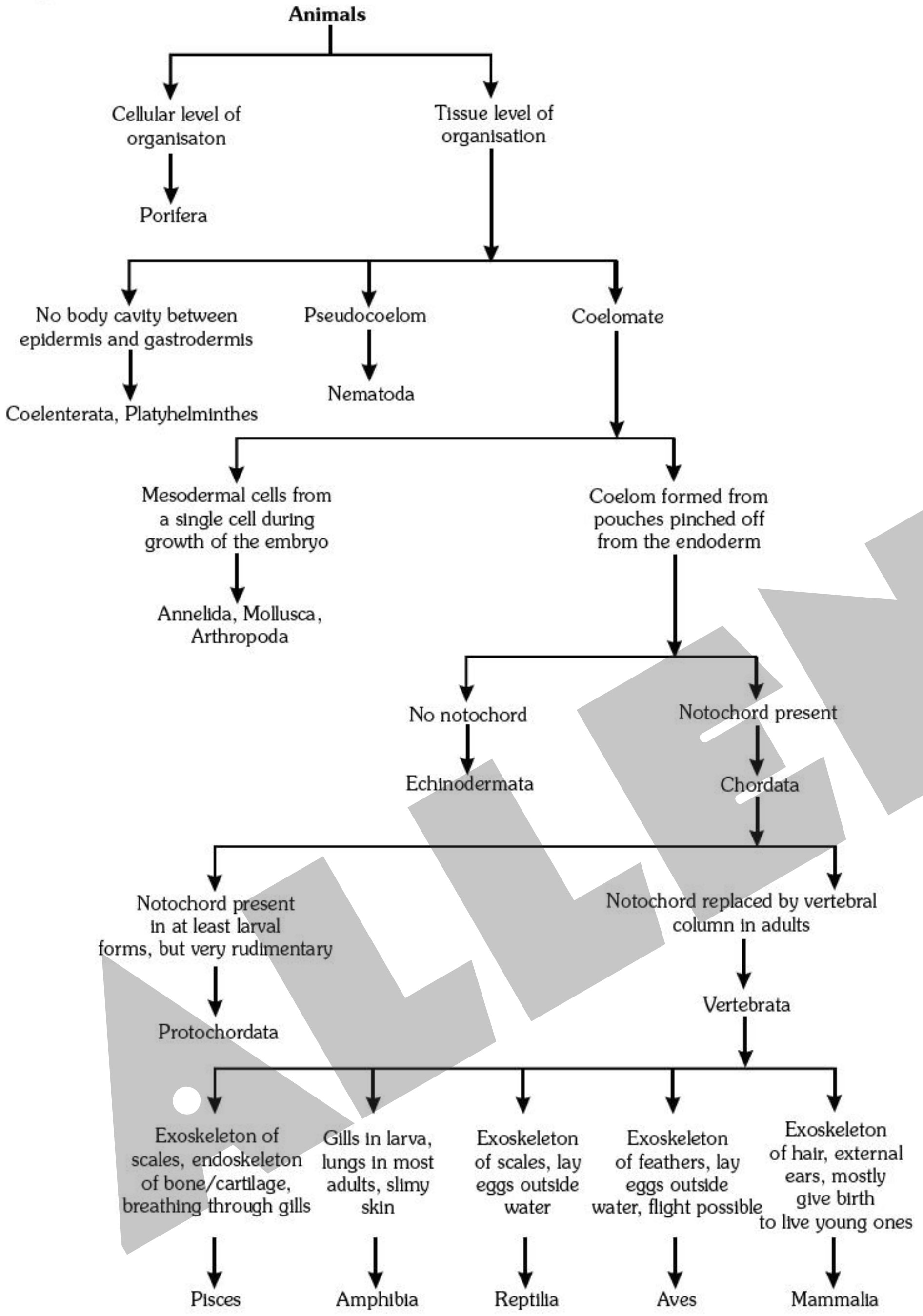
Animals
Cellular level of organisaton
Tissue level of organisation
Porifera
No body cavity between epidermis and gastrodermis
Pseudocoelom
Coelomate
Coelenterata, Platyhelminthes
Nematoda
Mesodermal cells from a single cell during growth of the embryo
Coelom formed from pouches pinched off from the endoderm
Annelida, Mollusca, Arthropoda
No notochord
Notochord present
Echinodermata
Chordata
Notochord present in at least larval forms, but very rudimentary
Notochord replaced by vertebral column in adults
Protochordata
Vertebrata
Exoskeleton of scales, endoskeleton of bone/cartilage, breathing through gills
Gills in larva, lungs in most adults, slimy skin
Exoskeleton of scales, lay eggs outside water
Exoskeleton of feathers, lay eggs outside water, flight possible
Exoskeleton of hair, external ears, mostly give birth to live young ones
Pisces
Amphibia
Reptilia
Aves
Mammalia

Classification of animals

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Porifera

(i) It includes sponges found in marine environment.
(ii) These are simple multicellulars which have no tissue and organs.
(iii) The body is perforated by a system of pores and water channels.
(iv) These are sedentary, radially symmetrical and mostly asymmetrical.
(v) Body is diploblastic with mesenchyme. The body wall having two layers -the outer dermal and the inner gastral layer. In between two layers there is a jelly-like, non-cellular mesenchyma.
(vi) Skeleton is made up with calcareous or silicaceous spicules.
(vii) They are mostly hermaphrodite and exhibit sexual reproduction. Asexual reproduction occurs by internal budding called gemmule.
(viii) For example, *Euspongia*, *Sycon*, *Euplectella, Spongilla*

Coelenterata

(i) They are diploblastic, having two layers endoderm and ectoderm and in between the two, mesoglia is present.
(ii) They have blind sac body plan.i.e., only one opening present called mouth.
(iii) The body wall bears peculiar stinging cells called nematocysts.
(iv) Body exhibit radial symmetry.
(v) Small tentacles are present around the mouth, mouth leads into the coelentron.
(vi) Asexual reproduction occurs by budding and sexual by ova and sperms.
(vii) Alternation of generation takes place in course of the life cycle. A fixed generation, known as polyp form, alternate with a swimming generation known as medusa form.
(viii) For example, Corals, Sea anemone, *Physalia*, *Hydra, Sea fan* etc.

Platyhelminthes

(i) They are also known as flat worms. They are acoelomates i.e. they do not possess a true body cavity.
(ii) They are triploblastic, consisting of three layers of cells, namely ectoderm, mesoderm and endoderm.
(iii) They are hermaphrodite and reproduce sexually.
(iv) Body is bilaterally symmetrical, dorsiventrally flattened.
(v) Usually parasitic, flame cells present for excretion.
(vi) For example, Tapeworm, *Planaria*, Liver fluke (free-living)

Nemathelminthes

(i) They are also known as round worms.
(ii) They are triploblastic, bilateral symmetrical, pseudocoelomate animal.
(iii) Respiratory and circulatory systems are lacking.
(iv) Sexes are separate, Sexual dimorphism.
(v) For example, *Ascaris, Wuchereria*.

Annelida

(i) The animals are triploblastic and possess a true coelom.
(ii) The body exhibit metameric segmentation.
(iii) They exhibit bilateral symmetry and well developed digestive, circulatory, excretory and reproductive system.
(iv) The central nervous system consists of two dorsally placed cerebral ganglia and a solid ventral nerve cord.
(v) For example, Earthworm, leech.

Arthropoda

(i) This is the largest phylum of animal kingdom, it comprises over 700,000 species.
(ii) The body is usually segmented externally.
(iii) A hardened, nonliving, exoskeleton containing chitin is secreted by the epidermis. The epidermis moults periodically as long as the animal continues to grow in size.
(iv) Usually highly developed muscular system is present.
(v) Coelom is greatly reduced, sexes are separate.
(vi) Arthropoda can be divided into 4 sub-phyla.
    (a) Insecta - Body divided into head, thorax and abdomen, thorax bears three pairs of jointed legs and two pairs of wings, e.g. mosquito, housefly, cockroach.
    (b) Crustacean - Hard chitinous exoskeleton, head and thorax are fused; head bear one pair of jaws and two pairs of antennae, e.g. prawn, and crab green gland for excretion.
    (c) Arachnida - Head and thorax fused and hind part abdomen, four pairs of legs, do not possess any wings or antennae, e.g. scorpion, spider.
    (d) Myripoda - Body divided into similar segment; similar pairs of limbs are present in all segments, e.g. millipedes, and centipedes.

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Mollusca

(i) It is the second largest group of animals.

(ii) They are coelomates, unsegmented, bilaterally symmetrical.

(iii) Main part of body is surrounded with a fold of tissue called mantle.

(iv) There is an exoskeleton made up of calcium carbonate.

(v) Respiration occurs by gills or ctenidia.

(vi) Circulatory system is of the open type. Blood contain haemocyanin (blue colour pigment).

(vii) For example, snail,octopus,bivalve,squid.

Echinodermata

(i) They have spiny exoskeleton.

(ii) These are exclusively marine animals.

(iii) They are coelomates, body is without segmentation and radially symmetrical (in adult).

(iv) Body lacks head and anterior end, circulatory system is greatly reduced.

(v) Digestive canal is complete, well developed water vascular system and tube feet are present.

(vi) Respiration takes place by gills, genital bursae or respiratory trees.

(vii) For example, star fish, brittle star.

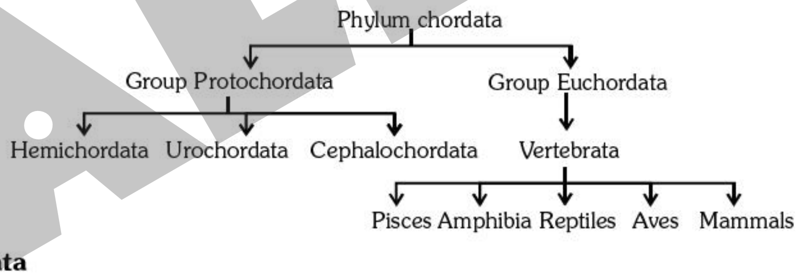
Chordata

Chordata is a phylum of triploblastic bilaterally symmetrical coelomate animals.

Notochord is a long rod-like structure that develops between dorsal nervous system and gut. Notochord functions as a support structure that provides points for attachment to muscles. Dorsal hollow nerve cord occurs above the notochord.

Pharyngeal gill slits (gill pouches) are paired respiratory structures which remain functional throughout life in fishes and some amphibians. In others they occur only in embryo.

Post anal tail occurs in most chordates for balancing, protection of genital and anal regions.



Protochordata

These animals are bilaterally symmetrical, triploblastic and have a coelom. Notochord is present at least at some stages during their lives. It provides a place for muscles to attach for ease of movement.

Protochordates may not have a proper notochord present at all stages in their lives or for the entire length of the animal. Protochordates are marine animals.

Protochordates may be grouped into following subphyla -

(i) Hemichordata (e.g. *Balanoglossus*)

(ii) Urochordata (e.g. *Herdmania*)

(iii) Cephalochordata (e.g. *Amphioxus*)

Hemichordates have notochord as buccal diverticulum or stomochord in proboscis. Notochord is present only in the tail of free living tadpole like larva in urochordata. Notochord, Nerve cord and pharyngeal gill clefts remain throughout the life span in cephalochordata.

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Vertebrates - Jawless & Jawed

All vertebrates possess a notochord at least for some time in their life history. This group has been named chordates due to the presence of notochord. In higher chordates, the notochord is replaced either completely or partially by a skeletal structure known as the vertebral column, such chordates are called vertebrates.

All vertebrates are chordates but all chordates are not vertebrates.

Vertebrates are divided into the following classes.

1. Pisces

It comprises of fish that live in sea or fresh water, is the largest of all vertebrates. These are cold blooded (poikilothermic) have a definite head, body and a tail. They have two chambered heart and gills for respiration. The body of fishes are covered with scales. They move by fins, they lay eggs. Fishes can be of two types- cartilaginous and bony.

(i) Cartilaginous fishes (chondrichthyes) - They have cartilaginous endoskeleton, stiff skin, mouth is ventrally situated, e.g. sharks, ray fish, dog fish etc.

(ii) Bony fishes (osteichthyes) - They have bony skeleton and soft skin. The mouth is terminally situated, e.g. Rohu, catla, hilsa.

2. Amphibia

They are capable of living in land and water, carnivores and cold blooded. Body is divided into head and trunk. Skin is smooth. Respiration takes place by means of lungs, skin and buccal cavity; gills are present during the larval stage. Heart is three chambered, sexes are separate, oviparous having external fertilisation. Metamorphosis occurs in life history. They have jelly like eggs and fertilization is external, occurs in water, e.g. Frog, toad, salamander. Amphibians are the first vertebrate which come out of water but these are not able to live on land permanently. These depend on water for their reproduction. Two pairs of pentadactyl (five digits) limbs are present. Digits without claws. Excrete either ammonia (by tadpole) or urea (by adults).

3. Reptilia

They are cold blooded (Poikilothermic). Body is covered with epidermis horny scales. Two pairs of pentadactyl limbs are present. Body is divisible into head, neck and trunk, tail is well developed in some and reduced in others. Heart is incompletely four chambered, only (crocodile has four chambered heart). Respiration by lungs, sexes separate. The embryo lies in fluid filled space called amniotic cavity. They have leathery water proof eggs, e.g. tortoises (Testudo), snake, and crocodile. Reptiles are first successful terrestrial animals but some are aquatic. Body is divided into head, neck, trunk and tail. Two pairs of pentadactyl limbs with incurved nails or claws and one pair of metanephric kidneys are present. They are uricotelic. (i.e. their main excretory waste is uric acid)

4. Aves

This class includes more than 9,000 species almost all of which can fly .The ability to fly is reflected in the typical features of birds-forelimb modified into wings, streamlined body with lungs provided with extra air sacs and hollow bones to reduce weight. All birds lay hard-shelled eggs. The beak and feet vary according to the diet and way of life. Birds have four chambered heart, and they are warm blooded (homoeothermic), fertilization internal. Sound producing organ at the junction of trachea and bronchi of birds is called syrinx.

(i) Flightless birds - Ostrich, Emu, Kiwi, Penguin.

(ii) Extinct flightless bird - Dodo

5. Mammalia

These are most evolved form of vertebrates. They have hairs on body, external ear pinna, are warm blooded and have mammary glands. The body cavity is unequally divided into two parts by a muscular partition called diaphragm. Four chambered heart is present. Mammals comprise three sub-divisions as follows :-

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(i) Prototheria (monotremes) - They exhibit characters of both reptiles and mammals, young ones are hatched by eggs and thereafter nourished by the mother's milk, e.g. duck-billed platypus and spiny anteater (echidna).

(ii) Metatheria(marsupials) - They are viviparous, the female bears an abdominal pouch so immature new born complete their development within this pouch. e.g. kangaroo and koala bear.

(iii) Eutheria - Their embryo remains attached within the female body by the placenta to supply the nutrition. e.g. lion, camel, humans.

3.8 Virus

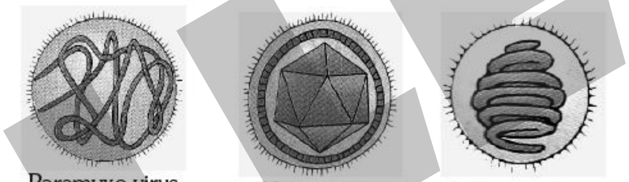
Viruses, viroids and lichens are not mentioned in Whittaker's classification.

Viruses are the link between living and non-living. They are non cellular having only two structures. Outer cover made up with the protein called capsid, made up with small units called capsomeres and nucleic acid (DNA or RNA). Viruses are inert or non-living outside the host cell, they are obligate parasites.

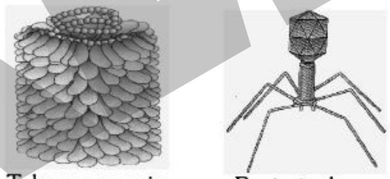
Genetic material is either DNA or RNA and it may be of different types- single stranded DNA ,double stranded DNA, single stranded RNA and double stranded RNA.

In general single stranded RNA viruses infect plants whereas animals are infected by all types. Some viruses attack on bacteria and they are known as bacteriophages. They are generally double stranded DNA viruses.

Viruses cause diseases like mumps, small pox, herpes, influenza, AIDS. In plants it causes mosaic, leaf rolling and curling, dwarfing and stunting of growth.



Paramyxo virus (mumps) Herpes virus Influenza virus



Tobacco mosaic virus Bacteriophage

Various types of Viruses

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Viroids

T.O.Diener in 1971 discovered a new infectious agent smaller than viruses that cause potato spindle tuber disease. It was found to be free RNA without protein cover and RNA was of low molecular weight.

EXERCISE

Multiple choice questions

1. Land plants that lack vascular tissues are
(1) Algae (2) Mosses (3) Ferns (4) Cycads

2. A parasitic sporophyte over gametophyte is found in
(1) Liverworts (2) Ferns (3) Chlorella (4) Horse tails

3. Sporophyte of Funaria consists of
(1) Capsule only (2) Seta and capsule (3) Foot and capsule (4) Foot, seta and capsule

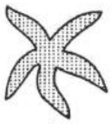
4. Which of the following statements are correct?
(1) Whittaker proposed the five kingdom system of classification.
(2) Carl Woese divided Monera into archaebacteria and eubacteria.
(3) Charles Darwin described the idea of evolution and wrote 'Origin of species'.
(4) All of the above

5. Seedless vascular plants are
(1) Liverworts (2) Mosses (3) Ferns (4) Cycads

6. Gymnosperms are characterised by
(1) Large leaves (2) Ciliated sperms (3) Naked ovules (4) Scale leaves

7. Bryophytes can be distinguished from pteridophytes as they
(1) Are thalloid forms (2) Do not have conducting tissue
(3) Contain chloroplast in their cells (4) Can live on land

8. Which one of the following animal possesses a water vascular system?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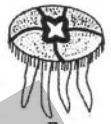
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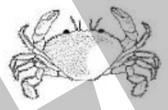
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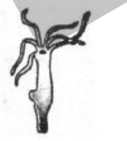
IV

(1) I (2) II (3) III (4) IV

9. Angiosperms have dominated the land flora primarily because of their
(1) Property of producing large number of seeds (2) Nature of self pollination
(3) Domestication by man (4) Power of adaptability in diverse habitat

10. Pseudocoelom is present in
(1) Annelida (2) Platyhelminthes (3) Nematoda (4) Protozoa

11. The causative organism of elephantiasis belong to phylum
(1) Arthropoda (2) Protozoa (3) Porifera (4) Nematoda

12. Which of the following is an egg-laying mammal?
(1) Duck-billed platypus (2) Kangaroo (3) Whale (4) Pigeon

13. In the Latin name *Salix nigra*, the first name is the ______ and second is the ______.
(1) genus, species (2) family, genus
(3) common name, scientific name (4) species, genus

14. Which of the following is the correct sequence of the taxonomic hierarchy?
(1) Division, Order, Family, Class (2) Division, Class, Order, Family
(3) Family, Division, Order, Class (4) Class, Order, Family, Division

15. What is classification?
(1) Grouping things together on the basis of the features they have in common
(2) Grouping things together on the basis of how they respire
(3) Grouping things together on the basis of how they feed
(4) Grouping things together on the basis of how they survive

16. Which is the most commonly used classification scheme?
(1) Linnaeus five kingdom scheme (2) Whittaker five kingdom scheme
(3) Darwin five kingdom scheme (4) Hooke five kingdom scheme

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17. Which of these is not included in the Kingdom Fungi?

(1) Plants with chloroplasts in their cells (2) Organisms with hyphae
(3) Organisms which grow on tree trunks (4) Moulds

18. Which of the following are characteristics of both bacteria and fungi?

(1) Cell wall, unicelluar and mitochondria
(2) Cell wall, DNA and plasma membrane
(3) Plasma membrane, multicellularity and Golgi apparatus
(4) Nucleus, organelles and unicellularity

19. The excretory organ in molluscs is the

(1) malphigian tubule (2) organ of Bojanus (3) flame cells (4) protonephridia

20. The flowering plant group, which is the biggest in the plant kingdom is

(1) Ferns (2) Angiosperms (3) Gymnosperms (4) Moss

21. Algae are similar to plants and were classified together because

(1) they have true leaves, stems and roots (2) they make their own food through photosynthesis
(3) they produce seeds (4) they do not prepare their own food by themselves

22. If two organisms are in the same phylum, they must also be in the same

(1) class (2) species (3) family (4) kingdom

23. Which of the following kingdom contains 'extremophiles'?

(1) Eubacteria (2) Archaebacteria (3) Fungi (4) Protista

24. Which of the following is not one of the five kingdoms of the Whittaker's classification system?

(1) Animalia (2) Monera (3) Protista (4) Chordata

25. 'Systema Naturae' was written by

(1) Darwin (2) Linnaeus (3) Aristotle (4) John Ray

26. The kingdom intermediate to kingdom Monera and multicellular organisms is

(1) Fungi (2) Animalia (3) Plantae (4) Protista

27. Vascular cryptogams are

(1) gymnosperms (2) fungi (3) bryophytes (4) pteridophytes

28. Angiosperms differ from gymnosperms

(1) in the type of secondary growth (2) in geographical distribution
(3) in the nature and enclosure of ovule (4) in the dispersal of seeds

29. If a seed is defined as an ovule modified as a result of fertilization, one may expect to find seeds in

(1) gymnosperms only (2) angiosperms only (3) all vascular plants (4) all phanerogams

30. The division of plants into gymnosperms and angiosperms terminates with the suffix 'sperm'. It means that both produce

(1) motile sperm (2) non motile sperms (3) seeds (4) sporophylls

31. A common character shared by pteridophytes and gymnosperms is the presence of

(1) ovules (2) vascular tissues (3) fruits (4) all of these

32. Pteridophytes differ from thallophytes and bryophytes in having

(1) highly differentiated plant body (2) true roots, stem and leaves
(3) well-defined vascular system (4) all of the above

33. In which of the following groups would you place a plant which produces spores and embryos but lacks seeds and vascular tissues?

(1) Fungi (2) Pteridophytes (3) Bryophytes (4) Gymnosperms

34. Double fertilization takes place in

(1) bryophytes (2) gymnosperms (3) angiosperms (4) pteridophytes

35. Acoelomate phylum is

(1) Nemathelminthes (2) Rotifera (3) Platyhelminthes (4) Annelida

36. All invertebrates are

(1) acoelomates (2) coelomates (3) cold blooded animals (4) warm blooded animals

37. Diploblastic, aquatic animals with tissue grade of organization belong to the phylum

(1) Protozoa (2) Porifera (3) Cnidaria (4) Helminthes

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38. Platyhelminthes worms are

(1) triploblastic, bilaterally symmetrical, pseudocoelomate animals
(2) triploblastic, bilaterally symmetrical, acoelomate animals
(3) triploblastic, bilaterally symmetrical, coelomate animals
(4) triplobalstic, bilaterally symmetrical, schizocoelomate animals

39. The distinguishing features of an annelida is

(1) pseudocoelom and flame cells
(2) pseudocoelom and longitudinal muscle in the body wall
(3) flame cells and longitudinal muscle in the body wall
(4) metameric segmentation and true coelom

40. The coelom in arthropods is reduced and known as 'haemocoel' because

(1) coelomic fluid flows in the blood vessel
(2) blood flows in the blood vessels present in the coelom
(3) coelom is filled with haemoglobin
(4) blood flows in the coelom

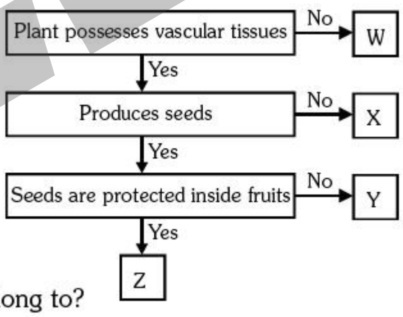
41. Given below are statements made by four students about Monerans.

(i) Monerans show multicellular body designs - Ashok
(ii) Monerans show either autotrophic or heterotrophic nutrition - Gita
(iii) All monerans possess cell wall - Ramesh
(iv) Blue-green algae is an example of Monera - Amit

Which of the student(s) has/have made an incorrect statement?

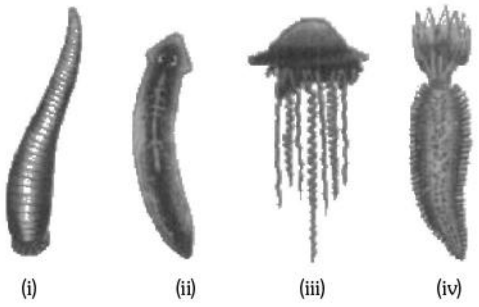
(1) Ashok & Ramesh (2) Ashok only (3) Gita & Ramesh (4) Amit & Ashok

42. Study the given flowchart. Which of the following are the correct examples of W, X, Y and Z?


Plant possesses vascular tissues
No
W
Yes
Produces seeds
No
X
Yes
Seeds are protected inside fruits
No
Y
Yes
Z

	W	X	Y	Z
(1)	Ulothrix	Marsilea	Selaginella	Cycas
(2)	Riccia	Marsilea	Cycas	Ipomoea
(3)	Lycopodium	Marchantia	Pinus	Ipomoea
(4)	Spirogyra	Dryopteris	Funaria	Pinus

43. Which phylum do the given animals (i), (ii), (iii) and (iv) belong to?



	(i)	(ii)	(iii)	(iv)
(1)	Annelida	Platyhelminthes	Coelenterata	Echinodermata
(2)	Annelida	Platyhelminthes	Echinodermata	Coelenterata
(3)	Platyhelminthes	Annelida	Coelenterata	Echinodermata
(4)	Platyhelminthes	Annelida	Echinodermata	Coelenterata

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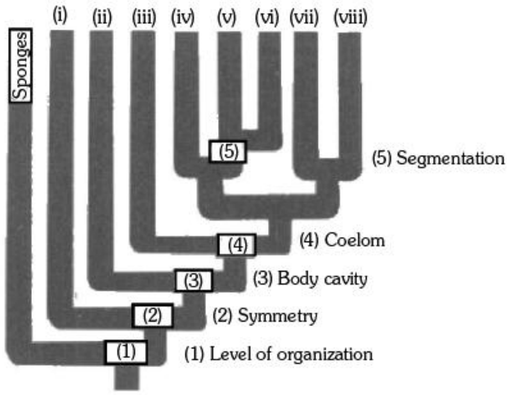
44. In the given phylogenetic tree, where would you place the following?

(P) Echinodermata (Q) Cnidaria (R) Annelida (S) Platyhelminthes



	P	Q	R	S
(1)	(vii)	(ii)	(v)	(i)
(2)	(viii)	(ii)	(vi)	(i)
(3)	(vii)	(i)	(v)	(ii)
(4)	(viii)	(iii)	(vii)	(i)

45. Four students observed some plants and recorded their observations and conclusions in the table below :

Name of the student	Observation	Conclusion
Suman	Body thallus-like	Algae
Rohan	Main plant body is a sporophyte.	Bryophytes
Mohit	Male and female gametophyte do not have an independent free living existence.	Gymnosperms
Meera	Chlorophyll bearing simple thalloid and autotrophic organisms which are attached to the substratum by rhizoids.	Algae

Which student(s) made the correct conclusion?

(1) Suman, Mohit & Meera (2) Mohit only

(3) Suman, Mohit & Rohan (4) Suman & Mohit

46. Which of the following characters can be used to distinguish gymnosperms from angiosperms?

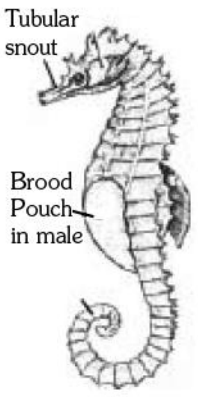
(1) Presence of pollen chambers in gymnosperms

(2) Presence of stomata in angiosperms

(3) Presence of naked ovules in gymnosperms

(4) None of these

47. The given figure shows an exclusively water living animal that occurs in tropical and temperate seas. Identify the figure and choose the category to which it belongs.



(1) Pisces (2) Echinodermata (3) Mammalia (4) Mollusca

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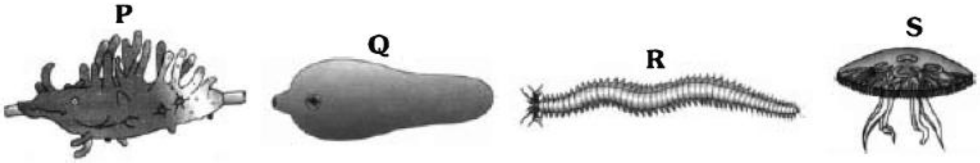
48. Identify the animals from the figures given below and mark the phylum to which they belong.



	P	Q	R	S
(1)	Mollusca	Echinodermata	Nematoda	Arthropoda
(2)	Echinodermata	Coelenterata	Annelida	Mollusca
(3)	Porifera	Platyhelminthes	Annelida	Coelenterata
(4)	Amphibia	Reptilia	Protochordata	Nematoda

49. Statement I : The common name of Exocetus is flying fish.

Statement II : Exocetus has wing like pectoral fins.

(1) Both statement I and statement II are true and statement II is the correct explanation of statement I

(2) Both statement I and statement II are true but statement II is not the correct explanation of statement I

(3) Statement I is true but statement II is false

(4) Statement I is false but statement II is true

50. Leech, Nereis, Scolopendra, Prawn and Scorpion all have segmented body organization, but still they cannot be classified in one group. Which of the following is the correct basis for the classification of these organisms into different groups?

(1) Leech and Nereis belong to the phylum annelida because they have metamerically segmented body.

(2) Scolopendra, prawn and scorpion belong to phylum arthropoda, as they possess jointed appendages.

(3) Leech, Nereis and Scolopendra belong to phylum annelida because they possess closed blood vascular system.

(4) Both (1) and (2)

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ANSWERS

Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.	2	1	4	4	3	3	2	1	4	3	4	1	1	2	1	2	1	2	2	2
Que.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Ans.	2	4	2	4	2	4	4	3	4	3	2	4	3	3	3	3	3	2	4	4
Que.	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**										
Ans.	1	2	1	3	4	3	1	3	1	4										